

A breath of fresh air



ABB is in the process of installing what will be one of the largest ventilation systems in the world at state-owned company Codelco's Chuquicamata copper mine, in Chile

Ventilation systems have become a lot more elaborate in the last few decades, providing monitoring, cooling and automated functions to allow for optimal clean air distribution. As battery-electric vehicles and machine automation start to impact the underground environment, Dan Gleeson spoke to several of the major solution providers to find out how they are reacting to this evolution

The need to go deeper in search of ore is causing mining companies to reconsider the use of innovative and digitally-enhanced technologies to look for profitable ways to develop new mining horizons.

With increasing depth comes increasing complexity, whether that is water ingress, heat, or exposure to harmful gases. This makes having a robust, efficient and cost effective ventilation system integral.

The ability to electrify underground mining equipment on a large scale has helped alleviate some of the cost and energy pressure put on miners plunging deeper underground. For instance, the use of electric vehicles at Glencore's Onaping Depth project, in Sudbury, Canada, which is set to reach 2,600 m below surface, is expected to reduce its energy usage by 44% for ventilation systems and by 30% for cooling equipment, compared with an equivalent diesel-fuelled operation.

This project would not stack up financially if using conventional diesel equipment, a point Michael Gribbons, Vice President – Sales and

Marketing at **Maestro Digital Mine**, picked up on.

“Diesel engines are far less efficient than electric engines and typically waste 60-70% of energy in the form of heat,” he told *IM*. “Diesel also requires additional ventilation requirements to clear the continuous emissions from the tail pipe.”

While the increasing uptake of battery- and tethered-electric equipment in the mining space will ease the burden placed on ventilation systems – in addition to improve the operating environment for miners – it will not solve all issues.

“The mine will still need to deal with the efficient removal of blast & strata gases and

heat since miners still need to go underground to operate and service the fixed equipment and operating fleet of production equipment,” Gribbons said.

The strata gas liberated with the removal of rock can be benign, toxic or, at times, deplete the available oxygen below acceptable levels, according to Gribbons. At greater depths, the air is denser and continues to pick up heat from exposed rock, he added.

Kim Trapani, Ventilation Engineer, and Pedram Rostami, Project Manager, Mining, at **Stantec**, agreed with Gribbons' assessment.

“In mines where electric vehicles are in operation, there is not a legislation airflow per



Maestro Digital Mine's Vigilante AQS is a third-generation underground mine air quality monitoring station designed with an improved communication platform

brake horsepower but rather a good air quality needs to be maintained (this needs to consider parameters such as temperature, silica dust, oxygen content, carbon dioxide content, etc). The main issues with deep mines will inevitably still be addressing the heat, mainly from strata, and the cooling/refrigeration challenges,” she told *IM*.

Howden Group’s Sales Director – Mining, Peter Terkovic, said there are still some unknowns when it comes to how battery-electric vehicles will impact underground ventilation requirements.

“How the transition from diesel to battery-electric vehicles affects mine ventilation design is yet to be seen because battery-electric vehicles are still an early-adopter technology,” he told *IM*.

“With that said, newer vehicles with lower air requirements may reduce the volumetric requirements for some phases of mine operations but heat control and blast clearing may become the new drivers for underground ventilation and overall capacity requirements may not change too much.”

Mines will still have to deal with the installation of underground booster fans and methods to chill the ventilation air so miners can continue to work in these environments, according to Gribbons. Both of these are “massive energy consumers”, he said.

Against this backdrop, the ability to regulate or reduce ventilation could have a marked impact on overall operating costs.

This has led to the advent of sophisticated monitoring systems that connect to other sensors and equipment to ensure optimal and efficient distribution of air to the active areas of a mine.

Maestro specialises in providing such solutions, with its Vigilante AQS™, Plexus PowerNet™ and Zephyr AQS™ systems deployed in over 125 mines globally.

While ventilation on demand (VoD) may be the ultimate solution for modern underground mines that can afford it, Gribbons said air quality monitoring, alone, can improve productivity by allowing miners to return to the face quicker and safer after a blast.

“For example, Rio Tinto’s Diavik mine reported a productivity improvement of 60 minutes per day by using the Vigilante AQS for monitoring blast gases,” he said. “These simple improvements can result in a return on investment of days to weeks since the solution is relatively inexpensive and simple to install.”

Vigilante AQS is a third-generation underground mine air quality monitoring station designed with an improved communication platform. The modular design provides flexible integration with any SCADA, PLC, DCS, PLS or HMI system, according to Maestro. Users can



plug the station into a network switch, configure the settings via the built-in web pages and start measuring, the company says.

Once these monitoring solutions are installed, mines can bolt on additional ventilation controls requiring greater capital expense and planning – including turning on and off auxiliary fans from surface – to achieve greater energy savings.

Demand

The next step is VoD.

“VoD systems can be operated to further reduce the ventilation requirement as long as the air quality where personnel are working underground is not compromised,” Stantec’s Trapani and Rostami said.

The decision to invest in such a VoD system often boils down to the return on investment it can offer, according to Trapani and Rostami.

“[It] is typically driven by the size and duration of the overall mining operation, with longer and bigger operating mines justifying the investment of these more expensive technologies and better systems,” Trapani and Rostami said.

Such mines may have noted the recent tie-up between **Mobilaris** and **Epiroc**, which has led to the integration of the Mobilaris Mining Intelligence (MMI) and Epiroc Serpent Ventilation platforms.

MMI is an information management platform that gathers data about where people, equipment and vehicles are at any given time, while Serpent offers a complete ventilation system for successful tunnelling and mining operations, including system design, fan station, ducting and installation.

Earlier this year, the two companies announced the deal, which will see ventilation requirements dictated by the presence of machines or equipment, the two companies told *IM*.

“As Mobilaris MMI has the capability of creating geo fences and knows the position of

The integration of the Mobilaris Mining Intelligence and Epiroc Serpent Ventilation platforms will see ventilation requirements dictated by the presence of machines or equipment, the companies say

equipment, a rule-based demand on the ventilation can be created when the machines enter the geo-fenced area,” they said.

This provides a VoD solution that, not only considers geo fencing, but also data from air quality sensors.

Combining the two methods ensures “a healthy work force environment, as well as keeping energy consumption under control”, the companies said.

Integration of this type has already been proven in the field.

At Boliden’s Kankberg mine, in Sweden, Mobilaris’ MMI partnered with **ABB** and the existing 800xA control system in place at the mine, on top of ABB’s own SmartVentilation system, to save 54% of ventilation energy and 21% of air heating energy in its first year after installation.

Mobilaris and Epiroc believe the new MMI-Serpent integration could bring even greater benefits.

“The integration gives the opportunity to monitor the ventilation system, itself, by monitoring vibration levels in the fan for predictive maintenance and monitoring the air flow via pressure sensors in the fans,” the companies said.

This monitoring could detect broken tubes, for example, which can reduce energy consumption further. “With correctly installed tubes, the ventilation air will come to the right place without unnecessary losses on the way,” they said.

Commenting on the energy savings that could come from the integration, Epiroc and Mobilaris said: “In general, the use cases and capabilities that can be supported depend on the depth of

the integration between the systems.”

This could involve a simple “presence-based installation” at one of end – proving immediate benefits – to deep integration at the other involving “sensor data, predicting airflow needs based on scheduling and movement patterns for the most advanced cases”, the companies said.

Sourcing and allocating the appropriate ventilation for a battery-electric machine in operation at an underground mine would be representative of more “advanced integration”, Epiroc and Mobilaris said.

“This is where the rule-based VoD in MMI comes in to play. If the machine entering the geo fence is battery-powered, which will be known by Mobilaris MMI, the system will tell the ventilation system that less air is needed compared to a diesel-powered machine entering the geo fence.”

Automation

Just as battery-electric vehicles are changing the ventilation dynamic, so too is automation.

If machines are operated tele-remotely, from surface or autonomously, the need to ventilate for an optimal worker environment decreases in line with the reduction in personnel working underground. Also, unmanned machines can re-enter a blasted area quicker than they would have in a manned-operator environment.

The complication comes with needing to keep temperatures at a level where it does not affect the operation of the equipment, and preparing for a service technician to enter a working area when an autonomous/tele-remote machine has a problem.

This is where the combination of automation and VoD can aid mine ventilation, with the communications and sensor infrastructure that comes with installing such solutions enabling efficient and critical ventilation distribution.

As the mines of the future will be digitalised, automated and hyper-connected, companies will have unprecedented visibility into, and control over, every facet of their operations, including ventilation, according to Jan Nyqvist, ABB Product Manager, Automation, Underground Mining.

This then places the onus on mining companies to ensure personnel operate in a safe working environment with access to clean air when and where they need it, Nyqvist said.

Envisaging mines free from CO₂, ABB has developed the ABB Ability™ Ventilation Optimizer, a complete ventilation control solution with VoD functionality.

“There is no need to ventilate the entire mine because production may only be concentrated in, say, 20% of the facility at any one time,” explained Nyqvist. “By controlling mine ventilation in this way, annual energy savings of

up to 50% are possible.”

Part of the ABB Ability package of digital solutions, the modular system uses sensors in the mine that transmit real-time information on toxic gases such as nitrogen dioxide emissions from diesel vehicles and blasting, CO₂ and methane, as well as dust and humidity levels, for analysis.

The Ventilation Optimizer system is divided into three “implementation levels” offering degrees of operational control over the mine’s intake and exhaust fans.

Level one offers centralised supervision and control of equipment from ABB Ability System 800xA Operator workplaces. “Personnel, for example, do not have to venture many kilometres underground in order to start a fan,” Nyqvist says.

Level two uses VoD to control equipment according to actual ventilation demands dynamically calculated from mine production schedules and events, and event equipment status and location.

Level 3 uses sensor feedback and advanced multivariable control technology to perform mine-wide control, and optimise air flow and quality, while reducing energy consumption in real-time.

“As part of level 3, we apply a more model-based algorithm to control all the fans underground, using a patented optimiser method to create a digital model of the ventilation system that is then able to control all fans in an optimised way,” Nyqvist said. “In the future, we hope to develop low-cost IoT sensors for fire scenarios or toxic source detection that will make the system even smarter.”

In addition to offering a safe working environment and significant annual energy savings, ABB Ability Ventilation Optimizer extends the lifetime of ventilation systems by optimising legacy infrastructure, the company says.

Complete portfolio

It has been a big few years for Howden Group with acquisitions across its ventilation platform and, more recently, a corporate transaction that has seen the company acquired by KPS Capital Partners.

The company manufactures fans, compressors, heat exchangers, steam turbines, and other air and gas handling equipment, and provides service and support to customers around the world, with over 5,300 employees, including more than 650 engineers, and 22 manufacturing facilities in 12 countries.

Last year, Howden added both Advanced Combustion Inc (ACI) and Advanced Fan Systems (AFS) to its expanding mine ventilation offering.

At the time, the company said: “This

acquisition is a further continuation of Howden’s total mine ventilation solutions strategy to provide the global mining industry with a portfolio of best-in-class products, controls and services that gives customers the most efficient solution to their ventilation needs.”

This followed the purchase of Chasm Consulting and its Ventsim software, in 2017, which provided Howden with a suite of solutions for mine ventilation, from modelling and design software to full turnkey projects including main and auxiliary fans, instrumentation, automation and VoD, via the Simsmart product line.

Asked about any potential gaps in the company’s portfolio, Howden’s Terkovic said: “We are now in the position to express with confidence that Howden no longer has any ‘gaps’ in their mine ventilation portfolio – we are a truly a full service provider of total mine ventilation solutions.”

He added that bolting on ACI, AFS and Chasm has enabled Howden to win more business through “new technologies, innovative solutions and trusting relationships”.

“The Ventsim software, specifically, is a world-class product, and is integral to enabling Howden to provide total mine ventilation solutions.”

It is this software Terkovic singled out when talking about the deepening of mines in both greenfield and brownfield mining operations.

“The Ventsim software allows ventilation engineers to identify and solve the ventilation challenges associated with deep mines,” he said, adding, “Howden’s class-leading ventilation, heating and cooling products ensure ultra-deep mines can then focus on mining ore.”

Secondary solution

It is communication with vehicles and personnel in relation to ventilation that has enabled **Minetek** to make, it says, its most significant move since entering the international mining supply market.

The Australia-based company recently revealed its secondary mine ventilation system, which, “offers power savings and control not yet seen in the underground mining industry.”

Its high output Axial Fan system uses a Mine Air Control (MAC) system to maximise return from its Performance on Demand (POD) units. These components, tailored to the end user, automatically sense how much air is needed in a heading at any time.

While the secondary underground fans optimise air flow, they eliminate much of the power traditionally wasted in such applications while performing across a very large operating range and meeting broad regulatory compliance parameters, the company said. Compared with the common standard twin-stage axial fan ventilation systems found on the market, the

Minetek High Output axial fan system is modular and, the company says, provides:

- Vastly reduced energy costs;
- Adequate air at the face;
- High levels of control;
- Sensor tracking to automatically adjust to real-time demand;
- High volume compliance;
- Rapid blast dust removal, and;
- Reduced noise output.

According to Minetek's Engineering Manager, Remy Bourcier, the High Output Axial Fan has been designed with underground mines in mind, with the MAC control system bringing the mine's fan system together with complete automation.

"Until now, the market has limitedly used high maintenance variable speed drives to provide some level of control to the air flow in secondary ventilation systems," Bourcier said. "But our system works on high pressure, steel fabricated impeller technology allowing operation at temperatures and conditions previously thought impractical for an axial fan – and we achieve this in seriously harsh environments."

Key to its cost efficiency is the POD system, an electronic controller that allows the fan to be regulated from very low flow requirements right through to more than double the duty point of a traditional vane axial fan.

With the use of the MAC System RFID trackers, the system constantly remains aware of what items of underground mining equipment are moving into the heading, so the POD controller can automatically adjust the air volumetric flow required to provide enough volume to disperse the gases and ventilate the area.

It will sense the specific truck that has entered the tunnel and be aware of the size of its engine and the number of people it will be carrying, automatically adjusting to meet the demand for sufficient ventilation for the people in accordance with industry regulation, Minetek says.

Contract wins

TLT-Turbo Africa is gearing up to start work on a turnkey solution for underground ventilation and fume extraction at Ivanhoe Mines' majority-owned Kamo-a-Kakula copper project in the Democratic Republic of Congo.

The contract was awarded by Kamo-a-Copper SA, a joint venture between Ivanhoe, Zijin Mining Group and the Government of the DRC, but DRA Projects appointed the ventilation specialist as part of its engineering, procurement, and construction management project remit.

As part of this supply and installation contract, TLT-Turbo Africa is designing, manufacturing and supplying a Bifurcated Axial Flow Fan Station for the extraction of mine fumes, as well as auxiliary and booster fans for Kamo-a's underground operation. The company will also oversee the



installation of the fans and provide assistance with commissioning.

TLT-Turbo said the project is the first of many of strategic importance within the Sub Saharan Africa region it is focused on.

Vusi Madlopha, head of Sales and Marketing-SSA, TLT-Turbo Africa, told *IM* its mining clients in sub-Saharan Africa have, in the past 18-24 months, been requesting smaller fan sizes and solutions as opposed to fixed, large installations, to cut down on construction costs and improve flexibility.

This trend is also apparent with the Kamo-a-Kakula contract, with Mike van Oerle, Sales Manager at TLT-Turbo Africa, saying the company's approach will provide several operating cost benefits.

The use of standardised equipment, designed for simple installation and maintenance, means TLT-Turbo's fans can be maintained by the client on site, without the need for costly expert inspections.

"TLT-Turbo is providing highly-efficient products to meet Kamo-a-Kakula's interim ventilation and power requirements, with flexibility for future redeployment at an alternative ventilation position," van Oerle said.

Madlopha said this most recent contract was representative of the type of enquiries the company has been receiving of late.

"In the past year, we've only received enquiries which require this kind of arrangement. The customers see real value in efficient, robust and flexible ventilation solutions," Madlopha said.

"Our Axial Flow Adjustable Pitch Fans allow the customer a wider range of operating points within the high-efficiency envelope, to enable the customer to turn down or ramp up output as and

As part of the supply and installation contract at the Kamo-a-Kakula underground copper project, TLT-Turbo Africa is designing, manufacturing and supplying a bifurcated axial flow fan station for the extraction of mine fumes, as well as auxiliary and booster fans

when the mine resistance decreases."

With this latest contract being for a greenfield operation, *IM* asked Madlopha about the different ventilation requirements the company is seeing from existing and new mining operations: "The greenfield requirements tend to understand that mine ventilation should be designed for the life of mine. The equipment selected should be able to perform during mine development, all the way through to decommissioning of the shaft.

"The brownfield projects are usually concerned with prolonging the useful life of the equipment and also the operation of a specific shaft. They would then have limitations in terms of civils and any other on-site design work."

In addition to having expertise with the greenfields mines, Madlopha was keen to stress the company's experience in providing retrofits for brownfield projects, where it has improved the operating efficiency of existing fan installations.

"We have successfully changed out fans in South African collieries, gold mines and platinum mines, which benefitted all our customers immensely during the previous round of the Eskom Demand Side Management program," Madlopha said.

And, TLT-Turbo's products can also be incorporated into autonomous VoD solutions.

"TLT-Turbo has always been at the forefront of advocating for automation of mine ventilation systems. Our fans are designed in a manner that they are ready for integration into any automated



The foundations for the fans to be installed at St Barbara's Gwalia underground gold mine will consist of over 1,500 t of concrete and 300 t of steel

ventilation system. The control philosophy can be easily adapted to suit the customer's requirements, without compromising the integrity or performance of the fans," Madlopha said.

One of TLT-Turbo's peers in the ventilation space, **AirEng** was recently contracted by St Barbara as part of a major investment project at the Australia-listed miner's Gwalia underground mine, just south of Leonora, in Western Australia.

A fully-owned subsidiary, and close collaborative partner of **The New York Blower Company**, AirEng aims to help mining companies reduce operating costs and boost safety by providing high efficiency mine ventilation solutions.

Its turnkey ventilation system for Australia's oldest and deepest gold mine – one looking to reach depths of 2,300 m by 2031, from 1,660 m currently – included primary fans, the electric power unit, and civil construction system.

Temperatures at the bottom of the mine hover around 87°F (30°C), which can be grueling for the 430 miners working underground, AirEng said. "A significant challenge for Gwalia is safeguarding workers at this level and getting chilled air from the surface to the workers below."

The fans, part of the multi-million-dollar contract, will sit about 60 ft (18 m) high and provide static efficiencies in excess of 85%, the ventilation specialist said. The foundations will consist of over 1,500 t of concrete and 300 t of steel, with the remainder of fan equipment being hauled to site on over 50 full semi-truckloads. AirEng anticipates the project will complete in late 2019.

Making the SHYFT

Sudbury-based engineering firm, **BESTECH** recently took the decision to spin off its technology solutions division into a new company called **SHYFTInc**.

SHYFT outlined the company brief earlier this year: "The company addresses real pain points and perceived obstacles that made mining executives reluctant to integrate new systems and technologies. The team is made up of engineers, automation and IT integration

specialists, product developers, and designers who work closely with clients to help them achieve and exceed their goals."

Focused on supporting digital transformation in the mining industry, SHYFT has been leveraging and marketing solutions originally developed under the BESTECH guise such as the AQM Air Quality Monitoring system.

This system is described by SHYFT as the largest air quality monitoring network in the world, developed to monitor air quality in Sudbury for Vale and Glencore operations. AQM collects sulphur dioxide levels and other air quality data from 20 stations in and around Sudbury and transfers the data via cellular communications, fibre or high-speed cable to both miners and the Ontario Ministry of the Environment.

It also has its flagship NRG1-ECO energy management and mine ventilation control system, which, SHYFT says, usually operates at peak capacity 100% of the time.

"NRG1-ECO allows for the automatic adjustment of a mine's ventilation system, providing air where and when it is needed," the company said. "It provides system control strategies that dramatically reduce a mine's energy consumption while maximising productivity, profitability and worker safety."

The latest add-ons to this solution harness the power of big data, artificial intelligence and machine learning to predict energy peaks, according to the company.

NRG1-ECO has been deployed at Vale's Totten mine, near Sudbury, and Rio Tinto's Diavik diamond mine in the Northwest Territories of Canada.

SHYFT also has the AutoGen IPnP automated process control solution within its portfolio. This "empowers small and medium enterprises to take control of their processes and devices by seamlessly integrating all equipment on a multi-vendor site", the company said.

"Following the initial setup of the control logic and interactions designed by automation specialists, you can take charge of setting up devices and managing their process through a simple drag-and-drop interface using Industrial-Plug-and-Play technology."

Chuquicamata dives below

ABB's global footprint extends to Chile, where it

is in the process of installing what will be one of the largest ventilation systems in the world at state-owned company Codelco's Chuquicamata copper mine.

Located 1,650 km north of Santiago, Chuquicamata is one of the largest and deepest open-pit copper mines in the world and is now about to go underground. ABB won the contract in December on the back of strong references from its Codelco Andina and Boliden projects, competitive pricing, the robust nature of its ventilation solutions and low life cycle costs, according to the company.

The scope of the commission covers engineering, delivery and installation of the control system, power and infrastructure, as well as engineering, delivery and design of ABB's ventilation control system and instrumentation, Ventilation Optimizer.

"We will be installing VoD in one block, around 10% of the mine, using more than 100 sensors distributed around 50 large booster fans, and then level 3 functionality on top of that," Nyqvist said.

In addition to the Smart Ventilation application, Ventilation System stimulator, and third-party integrations with location, traffic control and fire detection systems, ABB will install 109 air quality measurement stations, two weather stations, and control 47 fans, 22 regulators and 25 ventilation doors.

Environmental monitoring equipment made in the north west of England will also find its way to Chuquicamata underground, following an export deal for **Troxlex**.

Troxlex, founded in 1959, designs and manufactures gas detectors, air flow sensors and particulate monitors, among other equipment, to improve safety in hazardous environments including mines and tunnels.

The business, which has been working with Codelco since 2016, recently secured a £350,000 (\$438,841) contract for Chuquicamata underground, which could produce 300,000 t/y of copper when fully ramped up.

The contract is in addition to a £400,000 deal Troxlex sealed with EuroChem to supply its products to two new potash mines being constructed in Russia. 